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Right to Know (R2K)

Email: requests@righttoknow.ie

08 November 2018

Reference: AIE_12_1_280

Dear R2K,

I refer to your request for an internal review, on the basis that your request under the Access to Information on the Environment, (Amendment) Regulations 2007 to 2014 ("AIE Regs"), for access to records held by the University was not dealt with within the relevant period specified in article 7 of the regulations.

You requested the following information: "... environmental information relating to a study carried out in UCD and reported on RTE news on Monday 27 August - <https://www.rte.ie/news/2018/0827/987830-cheddar-does-not-raise-cholesterol-study/>

1. A list of parties (whether public or private) which fund Food Health Ireland and the amount of funding provided by each funder each year from 2016 to date
2. A list of who funded the study reported on by RTE and the amount provided by each of them
3. Copies of all correspondence (including attachments), meeting minutes, press releases and any other information provided to or exchanged with RTE in relation to the report."

Having considered the provisions of the Act, I have decided to part-grant you access to the requested records as follows,

1. The companies who fund Food Health Ireland are: Enterprise Ireland, Carbery, Dairygold, Kerry Group, Glanbia and Ornuia.
2. The companies who funded the study reported on by RTE are: Enterprise Ireland, Carbery, Dairygold, Kerry Group, Glanbia and Ornuia.
3. Please see the attached correspondences exchanged with RTE.

Refusal of access on the basis of confidentiality

Having considered the provisions of the AIE Regs (and the Freedom of Information Act 2014 ("FOI Act") where applicable) I have decided to refuse access to the funding records requested under parts 1 and 2 above on the basis that the requested records were provided in confidence to UCD.

Regulation 9(1)(c) allows a public authority may refuse to make information where disclosure would adversely affect "commercial or industrial confidentiality". Regulation 8(a)(iv) of the AIE Regs states a public authority may refuse access to information where disclosure would adversely affect the confidentiality of proceedings of public authorities as may be protected by the Freedom of Information Act 2014 ("FOI Act").

Guidance issued by the Minister for Environment, Community and Local Government in May 2013 ("Guidance"), states "if information about the proceedings of public bodies would, were an FOI request to be made seeking discovery of it, be capable of being protected under the [FOI Acts], a public authority must not release this information under [AIE Regs]. In this context, the attention of public bodies is directed, in particular, to the very considerable level of protection available under the [FOI Act] in respect of meetings of the Government and matters ancillary thereto. This level of protection should be applied, in full, to relevant requests under the [AIE Regs]". Therefore I have relied on Section 35(1)(b) of the FOI Act which states that a

head may refuse access to the records where “disclosure of the information concerned would constitute a breach of a duty of confidence provided for by a provision of an agreement”

The information you requested was given in confidence to UCD, on foot of a signed Consortium Agreement containing a confidentiality clause and, on the understanding, that the information would be treated as confidential. Disclosure of the information would constitute a breach of the confidentiality clause and would expose UCD to costly legal proceedings. In addition, it would prejudice the giving to UCD of further or similar information in the future. It is important for the work that is carried out in UCD that further and similar information should continue to be provided. Please note that the refusal to grant you the records stems from the confidential obligations placed on UCD and not from the nature of the information itself.

The enforceability of confidentiality provisions in agreements with public authorities may in some circumstances be challenged by the public authority's obligations to disclose information pursuant to the AIG Regs and/or the FOI Act. FOI bodies (and I would assert also public authorities under the AIE Regs) may not always bind themselves to complete guarantees of confidentiality, as it is an implied term of any contract that it will be subject to statutory obligations. The Information Commissioner has held that a confidentiality agreement with an FOI body can be overridden and information disclosed on the basis of the FOI Acts in certain circumstances where:

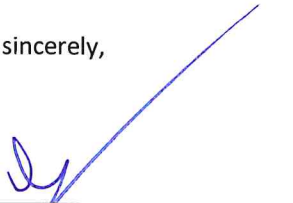
- the interests being protected by the agreement were those of the FOI body;
- the material at issue was “intrinsically significant” to the public interest;
- that releasing the information would not cause “significant damage to the public interest” or to any third party interest; and
- there is no compelling interest to maintain secrecy (*Sunday Times and North Eastern Health Board* (Office of the Information Commissioner Case No. 000528))

I assert that it is in the interest of UCD to protect the commercial decision of the funders of research, research which is taken in the public interest. Most importantly the amount of funding is not “intrinsically significant” to the public. However, the identities of the funders are and I have decided to disclose this information. There is a compelling interest to maintain the confidentiality merely as to the amounts of funding. In order not to prejudice the ability of the university to carry out commercial activities, it is important that third parties who engage with us are free to continue to do so.

As these records are of a financial, commercial, scientific and technical nature, I believe it is reasonable to take the view that disclosure would result in a material financial loss to both UCD and our industry partners and would prejudice the competitive position of all parties in the conduct of their respective businesses. The records are being withheld not due to the nature of the information but the nature of the harm which granting them might occasion. In addition, disclosure of these records would be likely to prejudice the giving of further similar information and would deter companies from disclosing commercially valuable information to UCD and other public bodies, therefore compromising the ability of public bodies to carry out commercial activities. The public interest test does not support release in this instance, due to the need for public bodies to operate in a commercial environment to the ultimate benefit of the taxpayer. In addition, there is a public interest in UCD being able to make informed decisions in the course of carrying out its function and in being able to maintain the confidentiality when working with industry partners.

Where you are dissatisfied with the outcome of the review, you can appeal in writing to the Office of Commissioner for Environmental Information, 18 Lower Leeson Street, Dublin 2. You have one month to make such a request, but in certain circumstances, late appeals may be permitted.

Yours sincerely,



Julian Bostridge
Solicitor and Manager of Legal Affairs

Encl (3)

Date: 11th July 2018

FHI contact: Jens Bleiel

Tel: 00 353 86 7815590

Irish Full fat cheddar cheese does not raise total blood cholesterol, finds FHI study

A Human intervention trial conducted by Food for Health Ireland scientists in University College Dublin, found that when Irish full fat cheddar cheese was consumed for 6 weeks, it did not raise blood cholesterol levels. This result was identified in comparison with groups that ate either half-fat cheese or butter with added protein and calcium. All groups consumed the same amount of fat. This study has just been published in the American Journal of Clinical Nutrition.

The aim of this study was to test the effect of dairy fat eaten in different forms. During the intervention trial, a total of 127 participants with elevated cholesterol were given (a) full fat cheddar cheese (which naturally includes protein and calcium), (b) reduced fat cheddar cheese plus butter – to make up to the same amount of fat found in full fat cheddar cheese (group a), or (c) butter plus separate sources of protein and calcium in equivalent amounts to that found in cheddar cheese. Group (a) had a significantly greater drop (-0.52 mmol/L (0.6 SD)) in total cholesterol compared to Group (c) (-0.15 mmol/L (0.64 SD)), with Group (b) falling in between the two groups (-0.36 mmol/L (0.55 SD)). This study suggests that the effect of cheese on cholesterol is greater when all of the fat is consumed in the form of full fat cheddar cheese. This is likely due to an additive effect of the nutrients contained within the structure of the cheese over and above that seen when the nutrients are consumed separately.

Since cheese is high in saturated fat, the consumption of it has been a target for reduction in those with cholesterol concerns. Typically, when diagnosed with high LDL-cholesterol, an individual is often told to reduce their consumption of foods rich in saturated fat, such as cheese.

Dr Emma Feeney, Principal scientist conducting the study, said: *“This is an exciting result that demonstrates the importance of what has become to be known as the ‘food matrix’ whereby you consider the food source of nutrients (the ‘matrix’) rather than simply nutrients alone. Our next steps in this area are to explore the ideal amounts of cheese required to generate these results.”*

FHI’s CEO, Mr Jens Bleiel said *“This is a great result for cheese as a healthy food product. It has potential to impact public health and food based recommendations in the future. It*

offers the opportunity to bring back cheese on the menu for those who were told not to eat cheese due to their elevated cholesterol levels. FHI will continue to do research to understand the health benefits of dairy ingredients and other dairy products for public health and well-being”.

ENDS

For more information, contact: Mr Jens Bleiel on 00353867815590 or fhi@ucd.ie

ADDITIONAL INFORMATION:

FHI is an industry led dairy research consortium co-funded by Kerry Foods, Carbery, Dairygold, Glanbia and Ornua and Enterprise Ireland. The research is conducted across the different Public Research Organisations (PROs) – UCD, UCC, UL, NIUMaynooth, NUIGalway, DCU and Teagasc Moorepark. The aim of the research consortium is to identify bioactive ingredients, derived from milk, that have a variety of health enhancing properties, all underpinned by excellent science and industrial potential and demand.

Debbie Scanlan

From: Jens Bleiel FHI <jens.bleiel@ucd.ie>
Sent: 13 August 2018 15:01
To: Will Goodbody
Cc: Fiona Lalor; Emma Feeney
Subject: Health benefits of Irish full fat cheddar cheese
Attachments: FINAL Press Release Cheese matrix .pdf; Untitled attachment 00431.htm; Dairy Matrix Paper AJCN full paper.pdf; Untitled attachment 00434.htm; PastedGraphic-1.pdf; Untitled attachment 00437.htm

Hi Will,

I hope you are keeping very well in this exceptional Irish summer.

When we were in Moorepark some time ago - where you did the piece on humanised milk fat in infant nutrition reducing the usage of palm oil - you may remember that we talked about our FHI research on Irish full fat cheddar cheese. We have obtained exciting and very convincing health results from a human intervention with in total 127 participants. These results have now been published in the American Journal of Clinical Nutrition, which is one of the most prestigious scientific journals. The results could indeed impact public health and food based recommendations in the future.

I attach the link to the article in the AJCN, a pdf version of the article in case you do not have access to the online journal, and also a short press release with the key findings. We are only communicating the results at this point in time to you, to Eilish O'Regan from the Irish Independent and to Dairyreporter.com before we will circulate the results to a broader audience.

Please let us know if you require any further information and we are very happy to accommodate your wishes. The lead Principal Investigator of the study, Dr. Emma Feeney is also copied in the mail.

Thanks a lot and kind regards

Jens

<https://academic.oup.com/ajcn/advance-article-abstract/doi/10.1093/ajcn/nqy146/5071782>

Dairy matrix effects: response to consumption of dairy fat differs when eaten within the cheese matrix—a randomized controlled trial

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ABSTRACT

Background: Dairy fat consumed as cheese has different effects on blood lipids than that consumed as butter. It is unknown whether the effect is specific to fat interaction with other cheese nutrients (calcium, casein proteins), or to the cheese matrix itself.

Objective: We aimed to test the effect of 6 wk daily consumption of ~40 g dairy fat, eaten within macronutrient-matched food matrices, on markers of metabolic health, in overweight adults aged ≥50 y.

Design: The study was a 6-wk randomized parallel intervention; 164 volunteers (75 men) received ~40 g of dairy fat/d, in 1 of 4 treatments: (A) 120 g full-fat Irish cheddar cheese (FFCC) (*n* = 46); (B) 120 g reduced-fat Irish cheddar cheese + butter (21 g) (RFC + B) (*n* = 45); (C) butter (49 g), calcium caseinate powder (30 g), and Ca supplement (CaCO₃) (500 mg) (BCC) (*n* = 42); or (D) 120 g FFCC, for 6 wk (as per A) (*n* = 31). Group D first completed a 6-wk “run-in” period, where they excluded all dietary cheese before commencing the intervention.

Results: There was no difference in anthropometry, fasting glucose, or insulin between the groups at pre- or postintervention. However, a stepwise-matrix effect was observed between the groups for total cholesterol (TC) (*P* = 0.033) and LDL cholesterol (*P* = 0.026), with significantly lower postintervention TC (mean ± SD) (5.23 ± 0.88 mmol/L) and LDL cholesterol (2.97 ± 0.67 mmol/L) when all of the fat was contained within the cheese matrix (Group A), compared with Group C when it was not (TC: 5.57 ± 0.86 mmol/L; LDL cholesterol: 3.43 ± 0.78 mmol/L).

Conclusion: Dairy fat, eaten in the form of cheese, appears to differently affect blood lipids compared with the same constituents eaten in different matrices, with significantly lower total cholesterol observed when all nutrients are consumed within a cheese matrix. This trial was registered at ISRCTN as ISRCTN86731958. *Am J Clin Nutr* 2018;108:1–8.

Keywords: cheese, food matrix, dairy fat, intervention study

INTRODUCTION

Intake of saturated fat is known to increase LDL-cholesterol concentrations, which is one of the known risk factors for cardiovascular disease (CVD) (1, 2). For this reason, current

dietary guidelines recommend that the daily intakes of SFA should be as low as possible (3), and should not exceed 10% of total energy intake (4). Population SFA intakes however are higher than this, standing at 13–14% of total energy from the most recently available Irish data (5), 12.6% in the United Kingdom (6), and 11.4% in the United States (7). Although dairy foods differ considerably in their fat content [see Thorning et al. (8) for an overview], dairy fat in general contains ~60% SFA. As such, dairy foods are a major contributor to SFA intakes, both in Europe and in the United States (9), contributing on average 20% of population SFA intakes. For this reason, most healthy eating guidelines tend to recommend “low-fat dairy,” such as the latest Dietary Guidelines for Americans (4).

Despite the fact that the recommendations that ≤10% of total energy should come from SFA encompass all dietary SFAs, the latest supporting evidence is more nuanced than this, suggesting that the food source of the SFA may be of particular importance (10). Recent meta-analyses suggest that although SFAs from meat and processed-meat sources are associated with detrimental health effects (11), SFA intake from dairy sources is associated with either neutral health effects (12, 13) or beneficial associations (11, 14–16). One caveat with many of the studies in this area is the use of “dairy” as a blanket term, which is unable to account for the fact that dairy products contain different components and fat content within different structures. In the studies that are able to distinguish between products, cheese appears to be associated with favorable outcomes. A recent analysis, which examined individual dairy food intakes and risk of CVD, coronary heart disease, or mortality (17), observed no

Supported by Enterprise Ireland (EI) grant TC-2013-001.

The sponsors had no influence on the execution of the study, the analysis, or the interpretation of data.

Supplemental Tables 1–3 are available from the “Supplementary data” link in the online posting of the article and from the same link in the online table of contents at <https://academic.oup.com/ajcn/>.

Address correspondence to ELF (e-mail: emma.feeney@ucd.ie).

Abbreviations used: %E, percentage energy; CVD, cardiovascular disease; FFCC, full-fat cheddar cheese.

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TABLE 1

Nutritional composition of the intervention diets (per day)

Diet	Intervention	Energy, kcal	Protein, g	Fat, g	Lactose, g	Calcium, mg
A	120 g full-fat Irish cheddar cheese	481.2	31.2	40.8	0.12	828
B	120 g reduced-fat Irish cheddar cheese + 21 g butter	517.0	30.0	43.2	0.12	900
C	49 g butter + 30 g calcium caseinate + CaCO ₃ supplement	476.2	27.3	39.2	0.01	817
D	120 g full-fat Irish cheddar cheese (as per "A")	481.2	31.2	40.8	0.12	828

beneficial associations for total dairy intake, but did observe benefits for fermented dairy, and specifically cheese (a 2% lower risk of CVD with cheese consumption). This is also supported by a meta-analysis of 15 cheese-specific prospective cohort studies on risk of CVD, stroke, or coronary heart disease (18), which found that high cheese consumption, compared with low, was associated with 10–14% lower risk of CVD.

In the last decade, a considerable amount of data has become available to support these observational studies. Randomized controlled intervention trials consistently demonstrate that the consumption of SFA in the form of cheese has different effects on blood lipid profiles compared with the same amount of SFA eaten in the form of butter (19–22), showing an overall reduction in LDL cholesterol for cheese compared with butter (19). Given that the SFA content of cheese and butter fat is essentially the same in terms of the individual fatty acids, this points to an effect of the food structure, or matrix, in which that fat is consumed.

To date, it is unknown whether there is an additive effect of the cheese structure or matrix over the individual cheese components. The aim of this study was to test the effect of 6 wk consumption of dairy fat in different structural matrices of equal fat, casein, and calcium content, on markers of metabolic health in a population of overweight adults aged ≥ 50 y, in a parallel intervention design. We hypothesized that dairy fat consumed in different matrices would have different effects on LDL cholesterol and other markers of metabolic health.

METHODS

Participants

We recruited 203 participants from Dublin, Ireland, and the surrounding area to participate in the study between September 2015 and July 2017. Inclusion criteria were: aged ≥ 50 y, with a BMI (kg/m^2) of ≥ 25 , but otherwise reportedly healthy, with no reported dairy intolerance or allergy. Exclusion criteria were: any prescribed medication for cholesterol or blood pressure-lowering reasons, any prescribed diet, or actively trying to lose weight. Participants gave written, informed consent before being enrolled on the study, and all study procedures were reviewed and approved by the University College Dublin Human Research Ethics Committee (LS-15-44-Feeney-Gibney).

Study design

The study was a randomized parallel-arm design with 4 intervention diet groups in a free-living cohort. Participants ($n = 203$) were randomly assigned to 1 of 4 dietary interventions: (A) 120 g of full-fat cheddar cheese (FFCC); (B) reduced-fat cheese plus butter; and (C) butter, calcium caseinate powder, and

calcium supplement (CaCO_3), each delivering ~ 40 g of dairy fat in different matrices daily, over 6 wk (shown in Table 1). The cheeses were both Irish white cheddar cheeses, aged 8–12 mo. A fourth group, Group D, followed the same intervention diet as group A for 6 wk, but they first completed a 6-wk run-in period where they abstained from all cheese in their diet. The 4 intervention diets were matched for energy, fat, casein, and calcium content. A total of 164 participants ($n = 75/46\%$ male) completed the intervention ($n = 46$ in Group A, $n = 45$ in Group B, $n = 42$ in Group C, and $n = 31$ in Group D). Reasons for dropping out were: demanding protocol ($n = 16$); feeling unwell ($n = 15$); lost to follow-up ($n = 2$); health problems unrelated to intervention ($n = 5$); and weight concerns ($n = 1$) (Figure 1). Owing to the nature of the intervention, it was not possible to blind either the volunteers or the researchers during the study periods; however, the blood biomarker analysis was all conducted blind to the intervention.

Intervention diets

The 3 intervention diets were matched as closely as possible (within the constraints of packaging sizes) for total energy, macronutrients, and calcium (Table 1), providing 489 ± 19 kcal/d. We asked participants to limit their intake of other dairy foods to 50 mL (2 oz) milk/d, but there were no other dietary restrictions. They were requested not to heat or melt the cheese. Participants kept a daily compliance record during the study, and recorded exactly how much of the study foods they consumed. Those who consumed $\geq 80\%$ of the study food (77.4% of participants) were deemed “compliant” for the purposes of the “Per Protocol” analysis ($n = 127$).

Measurements

We collected detailed anthropometry at baseline and postintervention (fasting body weight measured on a Tanita scale, Model BC-420MA, and height with a freestanding SECA stadiometer). Baseline and postintervention fasting blood samples (serum and plasma) were also collected. Dietary intakes were assessed via a 3-d food diary at baseline, and at 3–4 wk mid-intervention. The group who completed a run-in period of no dietary cheese (D) also came in for an additional pre-run-in visit, meaning that group D provided 3 measurements (shown in Figure 2).

Statistical analysis

The primary study outcome was change in LDL cholesterol from baseline to postintervention (6 wk) between the FFCC diet (A) and the FFCC + B diet (C). The study was powered to

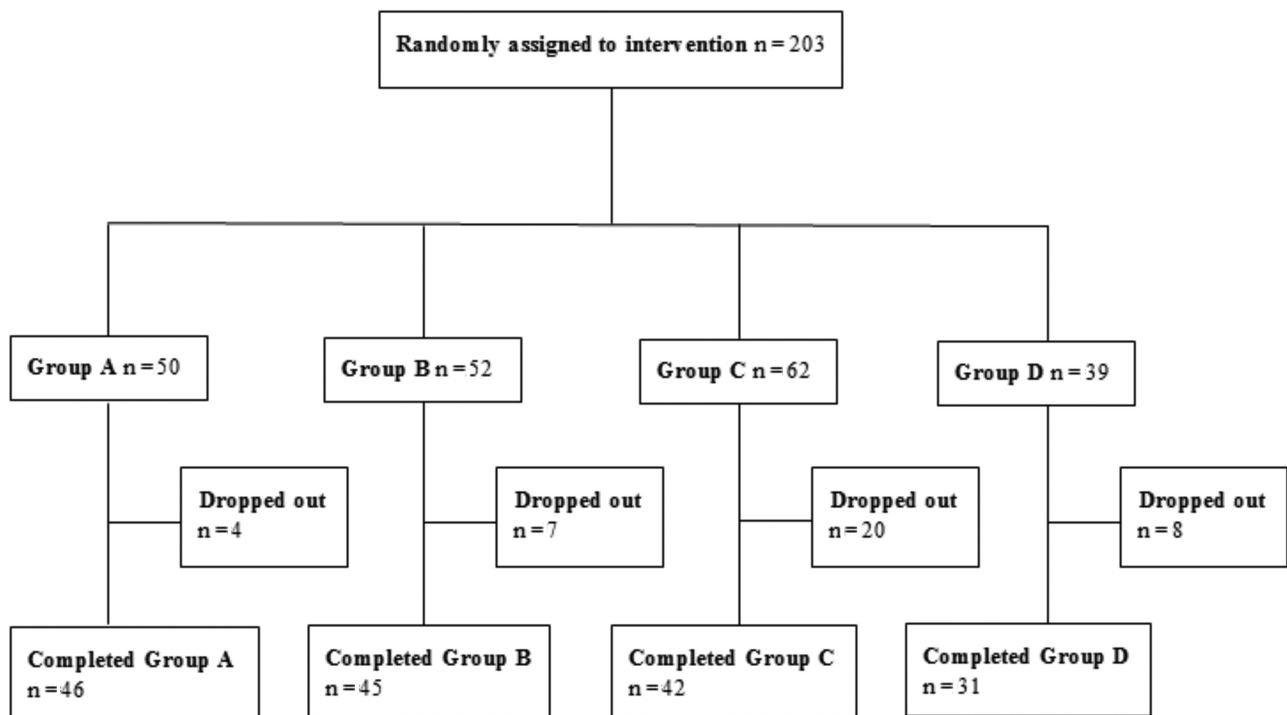


FIGURE 1 Participant flow chart. Of the $n = 203$ participants randomly assigned to the intervention, $n = 39$ did not complete the study. Reasons for dropping out were as follows: demanding protocol ($n = 16$); feeling unwell ($n = 15$); lost to follow-up ($n = 2$); health problems unrelated to intervention ($n = 5$); and weight concerns ($n = 1$).

observe a $\geq 20\%$ difference in LDL cholesterol between groups A and C, based on estimates from observed Irish data from the general population in this age group, with a mean LDL cholesterol of 2.92 mmol/L, SD 0.91 (23) ($n = 38$ required per group). A target of 60 recruited/group was set to ensure a minimum of $n = 45$ completing, allowing for a 25% dropout rate. In addition, the target group had a BMI ≥ 25 , meaning that they were more likely to have a higher than average LDL cholesterol, increasing the potential to observe a difference. Statistical analysis was performed with the use of SPSS version 24 for Windows (SPSS Inc., Chicago, IL). Descriptive analysis was performed on demographic, anthropometric, dietary, and clinical chemistry data for the total population and separated by group. Data were examined for distribution and nonparametric tests used where appropriate. Delta (Δ) scores were calculated by subtracting the postintervention from the preintervention values. Differences between groups for baseline values were tested via 1-factor ANOVA. Differences between groups for Δ values were assessed through the use of general linear models, controlling for baseline values, age, gender, Δ weight, and Δ percentage energy (%E) from SFA. Post hoc analysis was conducted via Fisher's least significant difference (LSD) test. A total of 164 participants completed the study ($n = 75/46\%$ male). Analysis was performed on both the total population of $n = 164$ (Completer approach), and on those who were $\geq 80\%$ compliant ($n = 127$) (Per Protocol approach). The results presented here represent the compliant group, as recommended by Welch and colleagues (24) for nutrition studies, whereby a "per-protocol" analysis is suggested to be more relevant for nutrition interventions, although it is recognized that this approach has a greater potential

for introducing bias into the comparison of interventions. The results for the total population (Completer analysis) followed the same trends as the Per Protocol analysis, and are available as supplemental data (Supplemental Tables 1 and 2).

RESULTS

Anthropometry

Participants' mean $\pm$ SD age (completers) was 60.3 ± 6.8 y (Table 2). Group A was slightly older at baseline than the other groups, at 63 ± 7 y. There were no other differences in gender or anthropometry between groups at baseline. After the intervention, there were no significant changes in anthropometric measurements postintervention between any of the groups; mean changes in body weight were $<1\%$ and, as such, not clinically relevant (25).

Biochemistry

Baseline total cholesterol was different between the groups ($P = 0.003$), being higher in group B than in the other groups (Table 3). Similarly, baseline HDL cholesterol was higher in group B. For this reason, analyses examining changes from baseline to postintervention (Δ) and absolute values were conducted adjusting for the baseline values. Absolute values are given in Table 3, and Figure 3 shows the Δ values for the 4 groups, including the 6-wk run-in period for group D.

There was a significant difference in the change in total cholesterol between the groups ($P = 0.033$). Post hoc analyses

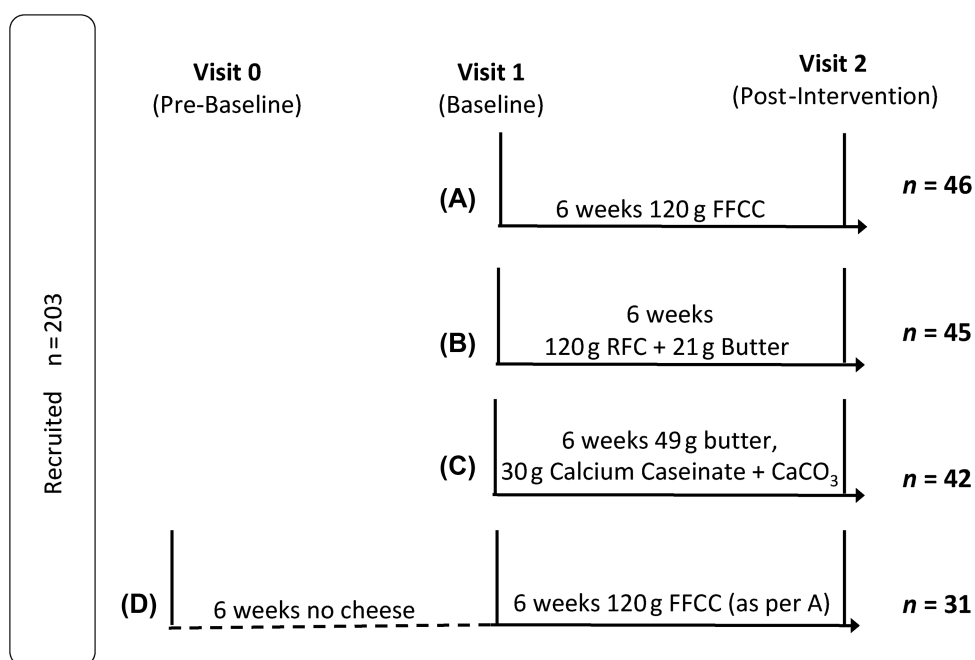


FIGURE 2 Overview of study design. The study was a randomized controlled design. Due to the length of time involved, participants completed 1 arm only (it was not a crossover trial). 203 volunteers were randomly assigned to groups A, B, C, and D. $n = 164$ completed the study (Completer analysis), and $n = 127$ were included in the Per Protocol analysis. In groups A, B, and C, ~ 40 g of dairy fat was consumed daily in different forms: (A) FFCC, (B) RFC + B, and (C) butter. In group D the participants followed the same intervention as group A, (FFCC) but they completed an additional 6 wk run-in (excluding all cheese from their diet) before beginning the study. Attrition rates were higher in groups C and D. FFCC, full-fat cheddar cheese; RFC + B, reduced-fat cheese plus butter.

indicated differences between groups A and B ($P = 0.031$) and A and C ($P = 0.008$). There was also a significant difference in the change in LDL cholesterol between the groups ($P = 0.026$). Postintervention LDL cholesterol values were significantly different between groups A and B ($P = 0.019$); groups A and C ($P = 0.018$); and groups A and D ($P = 0.016$). No difference was observed between the groups for HDL cholesterol. There were no significant differences in changes of the remaining metabolic markers between the groups during the intervention (triglycerides, nonesterified fatty acids, glucose, insulin, high-sensitivity C-reactive protein, and blood pressure). The results in the Completer analyses followed similar trends (Supplemental Tables 1 and 2).

Dietary data were examined to determine whether there were differences in intakes between the groups, either at baseline or during the intervention (Supplemental Table 3). This was done excluding the intervention foods, to ensure that the additional food intake from the intervention did not mask potential underlying differences. There were no differences between the groups at baseline for total energy, and %E from fat, carbohydrate, or protein. A small, significant difference was observed for %E at baseline from SFA ($P = 0.036$), with group C having higher %E from SFA at baseline compared with groups B and D. Similarly, there were no significant changes in diet throughout the intervention period between the groups for total energy, and %E from fat, cholesterol, or protein, whereas a small, significant difference was observed across the groups for %E from SFA. Percentage energy from SFA was slightly higher in groups A and D postintervention compared with groups B and C.

DISCUSSION

A number of previous studies have examined the effect of cheese consumption on markers of metabolic health in dietary intervention studies (21, 22, 26–28). In some cases these have examined the effect of calcium from different dairy foods (28), or of dairy fat in different dairy foods (21, 22, 27, 29). To date, however, the effect of the components of cheese held within the physical matrix has not been clear. Here, we aimed to test the individual cheese components themselves, and totally or partly within a cheese matrix, in a free-living intervention.

One previous study that used a pig model (30) took a similar approach, but did not appear to match the diets for calcium, as was done here, listing 600–900 mg/100 g diet for the butter, reduced-fat cheese, and FFCC diets. In that study, conducted in a group of 36 pigs, results conflict with those found in our study, whereby fasting total and HDL cholesterol were higher after 14-d intake of dairy fat in the form of regular-fat cheese compared with butter. Although they were able to feed relatively large amounts of cheese, and the porcine model was chosen because it closely mirrors the human lipid response to diet, Thorning and colleagues (30) further note that they added potato protein to the diets to meet the pigs' higher protein requirements, and may have inadvertently affected cholesterol metabolism in the pigs, as they had expected to observe a decrease rather than an increase in LDL cholesterol. Here, we observed a contrasting result whereby fasting total and LDL cholesterol were both significantly lower after 6 wk of dairy fat eaten in the form of FFCC (group A), compared with groups B and C. This supports a stepwise matrix effect whereby the

TABLE 2

Differences in demographics and anthropometrics across groups A, B, C, and D¹

	Group A (n = 40)	Group B (n = 36)	Group C (n = 28)	Group D (n = 23)	PV1	PΔ
Age, y	63 ± 7	58 ± 6	59 ± 7	60 ± 7	0.021 ²	—
Gender, n (%)						
Male	16 (40.0)	13 (36.1)	14 (50.0)	15 (65.2)	0.131 ³	—
Female	24 (60.0)	23 (64.2)	14 (50.0)	8 (34.8)		
Weight, kg					0.688	0.621
Visit 0	—	—	—	80.7 ± 9.6		
Visit 1	78.8 ± 13.9	76.9 ± 12.9	80.6 ± 14.4	79.8 ± 14.4		
Visit 2	79.1 ± 13.9	76.9 ± 13.0	80.6 ± 14.3	80.2 ± 9.1		
BMI, kg/m ²					0.740	0.657
Visit 0	—	—	—	27.2 ± 2.3		
Visit 1	27.6 ± 2.7	27.2 ± 3.9	27.9 ± 4.2	26.9 ± 2.1		
Visit 2	27.7 ± 2.7	27.3 ± 3.9	27.9 ± 4.2	27.1 ± 2.1		
Body fat, %					0.133	0.797
Visit 0	—	—	—	29.9 ± 7.6		
Visit 1	34.4 ± 7.9	33.8 ± 7.0	33.0 ± 7.9	29.8 ± 8.1		
Visit 2	34.1 ± 7.9	33.7 ± 8.0	33.4 ± 8.1	30.4 ± 6.8		
Waist circumference, ⁴ cm					0.542	0.476
Visit 0	—	—	—	95.5 ± 10.8		
Visit 1	96.6 ± 10.8	94.4 ± 11.5	97.9 ± 11.1	94.5 ± 9.9		
Visit 2	96.0 ± 11.5	93.6 ± 10.9	97.1 ± 11.6	95.2 ± 10.1		

¹n = 127, “Per Protocol” cohort. Values are means ± SDs unless specified. PΔ, differences across groups for delta values (visit 2 – visit 1) calculated with 1-factor ANOVA; PV1, differences across groups for visit 1 calculated with 1-factor ANOVA or Kruskal-Wallis nonparametric ANOVA where appropriate.

²Significant differences for age between groups A and B (*P* = 0.004) and groups A and C (*P* = 0.025).

³Chi-square test.

⁴n = 120 for waist circumference.

reduction was greatest when dairy fat was eaten completely in the matrix of cheese, less marked when the fat was contained only partly in the matrix, and the difference was not significant when the fat was not within the cheese matrix (i.e., completely from butter). Group D, who completed a 6-wk “no cheese” run-in diet before consuming FFCC, were also different compared with Group A. Although we expected the results in this group to mirror those of group A, this finding may reflect a lack of power in this group due to the lower completion rate (there were *n* = 15 fewer than in group A), which is one limitation of the present study. The higher dropout rate in D is likely attributable to the much longer period of intervention (12 compared with 6 wk) for this group of participants, because the diet itself once they completed the run-in was the same as for group A. Group C also experienced a higher dropout rate, attributable to the lower palatability of this diet compared with the other cheese-based diets. In addition, a greater percentage of men completed the C arm, possibly due to a greater willingness than women to incorporate protein powder in their diet. Although all analyses adjusted for gender, these group differences are also a limitation of the study. Another limitation which must be noted is the “Per Protocol” approach that was taken here for the primary analysis. This approach resulted in a much smaller cohort (*n* = 127) in the primary analysis compared with the overall number of completers (*n* = 164), increasing the potential to introduce bias into these results through a reduction in power and potentially accuracy. This approach was taken owing to the fact that the study protocol was difficult to follow, more so in some groups than in others (as evidenced by the different dropout rates described previously). In groups B and C, it was possible for noncompliant volunteers

to differentially consume parts of the study foods. Because the aim was to test the matrix effect and keep the overall ratio of components as similar as possible, this “Per Protocol” approach was deemed likely to be more representative of the true effect of the cheese matrix; however, the potential for the introduction of bias with this approach cannot be ruled out. A further limitation is the lack of intention-to-treat analysis here, which is the recommended approach in clinical trials owing to minimizing the risk of Type 1 error (31). This approach was not possible here, because complete outcome data were not available for all randomized subjects, due to dropouts who did not return for follow-up appointments.

There was no difference in the change in HDL cholesterol across the groups, suggesting that all the changes in total cholesterol observed were driven mainly by differences in LDL cholesterol. In contrast, some other groups examining cheese and butter have previously reported a small but significant increase in LDL cholesterol after an intervention period of butter consumption (21, 22). Tholstrup et al. (21) examined the effect of fat from butter, milk, and cheese, and adjusted the casein amounts in their study. They observed that LDL cholesterol concentrations was significantly higher after the butter diet compared with either the cheese diet or the run-in diet, despite the adjustment for casein. This finding led Hjerpested and colleagues (22) to suggest that the higher protein content of cheese is unlikely to explain the neutral effect of cheese on blood lipids. Here however, we adjusted both casein and calcium in the butter diet, and observed a downward trend for LDL cholesterol in all groups, suggesting that the additional calcium and protein components of cheese may work together to attenuate the effect of butterfat.

TABLE 3Differences in biochemistry and blood pressure data across groups A, B, C, and D¹

	Group A	Group B	Group C	Group D	PV1	PΔ
Total cholesterol, mmol/L						
Visit 0	—	—	—	5.07 ± 0.69	0.003 ²	0.033 ³
Visit 1	5.75 ± 1.09	6.18 ± 0.98	5.72 ± 0.70	5.23 ± 0.78		
Visit 2	5.23 ± 0.88	5.81 ± 0.91	5.57 ± 0.86	5.13 ± 1.05		
HDL cholesterol, mmol/L						
Visit 0	—	—	—	1.45 ± 0.24	0.023 ⁴	0.284
Visit 1	1.73 ± 0.49	1.79 ± 0.57	1.56 ± 0.33	1.46 ± 0.25		
Visit 2	1.73 ± 0.49	1.72 ± 0.49	1.61 ± 0.36	1.48 ± 0.25		
LDL cholesterol, mmol/L						
Visit 0	—	—	—	3.14 ± 0.62	0.031 ⁵	0.016 ⁶
Visit 1	3.42 ± 0.87	3.85 ± 0.90	3.57 ± 0.66	3.27 ± 0.62		
Visit 2	2.97 ± 0.67	3.58 ± 0.85	3.43 ± 0.78	3.20 ± 0.86		
Triglycerides, mmol/L						
Visit 0	—	—	—	1.05 ± 0.44	0.272	0.386
Visit 1	1.32 ± 0.57	1.19 ± 0.47	1.30 ± 0.61	1.10 ± 0.48		
Visit 2	1.17 ± 0.43	1.14 ± 0.46	1.18 ± 0.48	0.99 ± 0.29		
NEFAs, mmol/L						
Visit 0	—	—	—	0.52 ± 0.22	0.204	0.868
Visit 1	0.63 ± 0.30	0.68 ± 0.36	0.62 ± 0.29	0.50 ± 0.25		
Visit 2	0.56 ± 0.23	0.59 ± 0.30	0.61 ± 0.34	0.48 ± 0.29		
Glucose, mmol/L						
Visit 0	—	—	—	5.80 ± 0.33	0.255	0.481
Visit 1	6.15 ± 0.52	6.14 ± 0.58	6.24 ± 0.77	5.91 ± 0.42		
Visit 2	5.99 ± 0.54	5.90 ± 0.46	5.87 ± 0.77	5.69 ± 0.23		
Insulin, mU/L						
Visit 0	—	—	—	8.09 ± 4.40	0.828	0.253
Visit 1	6.00 ± 2.89	5.51 ± 2.56	5.56 ± 3.31	5.34 ± 3.38		
Visit 2	8.27 ± 4.51	7.18 ± 3.45	6.20 ± 4.37	7.49 ± 3.23		
hs-CRP, mg/L						
Visit 0	—	—	—	1.97 ± 2.26	0.243	0.705
Visit 1	2.52 ± 2.98	2.62 ± 2.08	1.97 ± 1.91	2.84 ± 4.80		
Visit 2	2.35 ± 1.88	2.09 ± 2.02	2.00 ± 2.67	2.55 ± 4.39		
SBP, ⁷ mm Hg						
Visit 0	—	—	—	128.3 ± 16.2	0.326	0.419
Visit 1	131.4 ± 15.8	130.7 ± 20.9	127.3 ± 17.0	123.1 ± 17.7		
Visit 2	127.9 ± 20.9	129.7 ± 19.5	126.0 ± 18.8	121.2 ± 11.5		
DBP, ⁷ mm Hg						
Visit 0	—	—	—	80.6 ± 9.4	0.206	0.924
Visit 1	82.5 ± 12.5	85.1 ± 12.8	81.3 ± 11.7	78.3 ± 9.8		
Visit 2	80.7 ± 11.6	83.0 ± 11.2	81.8 ± 11.7	78.2 ± 7.5		

¹*n* = 127. Values are means ± SDs. DBP, diastolic blood pressure; hs-CRP, high-sensitivity C-reactive protein; NEFA, nonesterified fatty acid; PΔ, differences across groups for delta values (visit 2 – visit 1) calculated with general linear models controlling for baseline values, age, gender, Δ percentage energy from SFA, baseline values Δ weight for glucose and insulin—post hoc comparisons were conducted with Fisher's least significant difference (LSD) test; PV1, differences across groups for visit 1 calculated with 1-factor ANOVA or Kruskal-Wallis nonparametric ANOVA where appropriate; SBP, systolic blood pressure.

²Significant differences for total cholesterol at visit 1 between groups A and B (*P* = 0.048).

³Significant differences for Δ total cholesterol between groups A and B (*P* = 0.031) and groups A and C (*P* = 0.008).

⁴Significant differences for HDL cholesterol at visit 1 between groups A and D (*P* = 0.023), groups B and C (*P* = 0.046), and groups A and C (*P* = 0.008).

⁵Significant differences for LDL cholesterol at visit 1 between groups A and D (*P* = 0.019) and groups B and D (*P* = 0.007).

⁶Significant differences for Δ LDL cholesterol between groups A and B (*P* = 0.016), groups A and C (*P* = 0.015), and groups A and D (*P* = 0.009).

⁷*n* = 122.

A further potential limitation here of the study design is that we used CaCO₃ and not a dairy form of calcium such as calcium phosphate. Another limitation is the smaller number of completers in group C, and the lower level of compliance in group C to the study food (*n* = 40 in group A compared with *n* = 28 in group C). Although efforts were made to provide recipes for the study foods for this group, the participants found it more difficult to adhere to than those in the cheese groups. This will

have affected the ability to see the differences between these groups. The inability to blind the subjects to the different diets in this free-living setting was also a limitation and may have added potential bias because the participants were aware of what they were eating, which could have had an impact on feelings of satiety and subsequent food intake.

Of note was the finding that there was no difference across the groups for change in fasting glucose concentrations or fasting

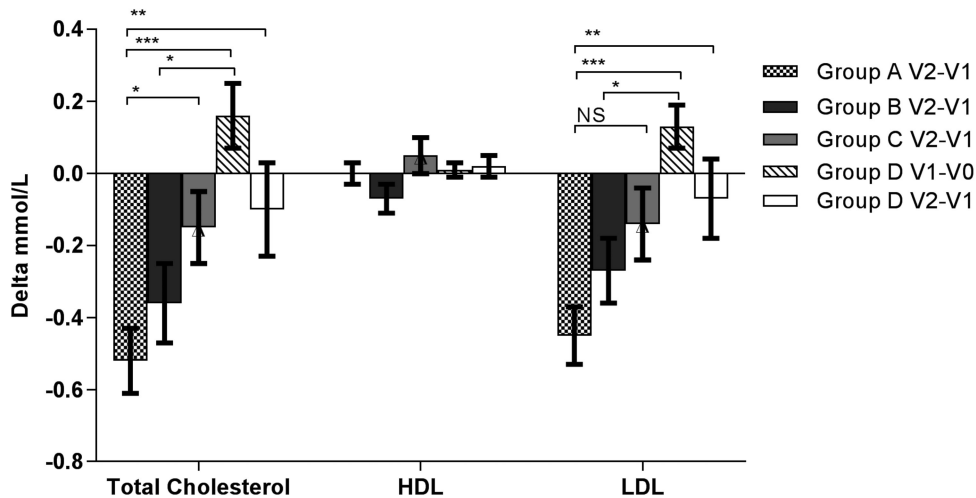


FIGURE 3 Changes in total, HDL, and LDL cholesterol (mmol/L) for delta visit 2 – visit 1 ($\Delta V2-V1$, all groups) and delta visit 1 – visit 0 ($\Delta V1-V0$, group D only). Values are mean differences $\pm$ SEMs. Differences between groups for $\Delta V2-V1$ scores were assessed by a general linear model controlling for baseline values, age, gender, and Δ percentage energy from SFA. Post hoc comparisons were conducted with Fisher's least significant difference (LSD) test. Significant differences for $\Delta V2-V1$ were observed between groups A and B ($P = 0.031$) and groups A and C ($P = 0.008$) for total cholesterol. For LDL cholesterol, significant differences for $\Delta V2-V1$ were observed between groups A and B ($P = 0.016$), A and C ($P = 0.015$), and A and D ($P = 0.009$). NS $P \geq 0.05$; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. V, visit.

insulin. This contrasts with the findings of Hjerpsted et al. (22) who observed an increase in fasting glucose after 6 wk of a cheese diet compared with butter, and no effect on fasting insulin. Because the other cheese components were adjusted for in this study, the reason for this difference may have been due to the additional protein and calcium balancing out the potential differences between dairy fat in different food matrices. The participants here were slightly older than those of Hjerpsted and colleagues, with a mean age of 60.3 ± 6.8 y compared with 55.5 ± 12.4 y, and Hjerpsted's study also had a wider age range (22). In addition, mean BMI was greater here, at 27.6 ± 3.5 compared with 25.3 ± 3.3 , and the subjects here had higher fasting glucose concentrations at baseline [6.08 ± 0.59 compared with 5.59 ± 0.06 mmol/L reported by Hjerpsted and colleagues (22)]. Dairy fat intake, more generally, has previously been linked to improved glycemic function; Kratz et al. (32) observed an inverse association between markers of dairy fat intake and fasting glucose concentrations, and response to an oral glucose tolerance test. In a similar study design to this one, conducted in a pig model, Thorning and colleagues (30) observed a decrease in short-chain fatty acid-producing bacteria after consumption of regular-fat and reduced-fat cheese diets, compared with butter. Because short-chain fatty acid concentrations are associated with insulin sensitivity (33), this could potentially explain some of the previous associations of dairy fat intake and glycemic function. Unfortunately, fecal samples were not collected in the present study so it is not possible to comment further on this. Future work would also require a nondairy fat control arm to explore this more fully.

It is possible that the small differences in cohort profile, combined with the extra protein intake in this present study, may explain the different findings for fasting glucose by Hjerpsted and colleagues (22) compared with those presented here. Snorgaard et al. (34) concluded, in a recent systematic review, that a reduction in carbohydrate intake and higher fat intake in overweight and obese diabetics result in beneficial effects on

glycemic status. Because the additional dietary elements here contained mainly fat and protein, the observed results for fasting glucose may have arisen from the change in %E from carbohydrate, which would have been similar across the groups. It would be interesting to test the same dietary macronutrient compositions with the use of different protein and fat sources to better understand the underlying mechanistic reason for these results.

Overall the results here suggest that each individual component of cheese may have a small individual effect on a variety of parameters of metabolic health, but these are additive when combined in the cheese matrix.

In conclusion, a diet consisting of 6 wk of ~ 120 g cheese/d in addition to the normal diet, or the equivalent macronutrients in different dairy matrices differentially affected a range of markers of metabolic health in an over-50s cohort of slightly overweight free-living Irish adults, depending on how much of the fat was contained within the cheese matrix. There was no difference in fasting glucose or insulin between the groups, whereas a stepwise difference was observed in total cholesterol and LDL cholesterol. Fat contained in the matrix of cheese resulted in significantly lower LDL and total cholesterol compared with the same components eaten as butter, protein, and calcium, suggesting a significant effect of the food matrix itself on blood lipid profiles. These results appear to confirm that dairy fat consumed in the matrix of cheese, even when eaten in large amounts, does not adversely affect blood lipid profiles in those at risk of metabolic disease.

Glanbia Plc, Carbery Food Ingredients Limited, and Kerry Group all supplied the test foods used in this study.

The authors' responsibilities were as follows—ELF and ERG: designed the study; TB, YP, LT, CF, PB, and NN: contributed to study design; ELF, VD, ZH, and RB: conducted the study; ELF, RB, and ERG: performed the statistical analyses; ELF: wrote the manuscript and had primary responsibility for the final content of the manuscript; ERG: provided valuable knowledge and scientific consultation throughout the study; TB and ERG: critically

reviewed the manuscript; and all authors: read and approved the final manuscript. ELF, ERG, TB, ZH, NN, RB, and VD have received funding from Food for Health Ireland, a dairy technology center part-financed by Enterprise Ireland and partly by dairy companies in Ireland. YP, PB, CF, and LT are dairy industry-affiliated authors. The industry-affiliated authors were invited to comment on the initial study design, but the researchers made the final decisions.

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